AFE 76s2 Report
Derivation of Radar Altimeter Interference Tolerance Masks

Volume I: Introduction, Test Procedures, and Fundamental Test Results

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3.3.3 2000 Feet AGL

3.3.3.1 Summary

Table 3-35: UC2 2000' AGL Test Conditions

Source	Rationale	Signal Type	Characteristics	Setting
VSG	5G Fundamental OOBI	OFDM	100 MHz TM1.1 centered at 3750 MHz, 3850 MHz, 3930 MHz	Power Sweep
VCOs 1-2	Own-ship multiplex installation	FMCW	CF: 4300 MHz BW/Sweep Rate per AUT	ON*
VCOs 3-16	WCLS – other aircraft	FMCW		OFF

* – For altimeters capable of multiplex operation. Altimeters I and V had VCO's 1-2 turned off.

Table 3-36: UC2 2000' AGL OOB Fundamental Emissions Break Points

	2000 ft, Own-Ship VCOs											
	3750 MHz				3850 MHz				3930 MHz			
Altimeter	ME	1%	99%	NCD	ME	1%	99%	NCD	ME	1%	99%	NCD
A	-10 dBm	-10 dBm	-9 dBm	-9 dBm	-14 dBm	-15 dBm	-14 dBm	-14 dBm	-20 dBm	-20 dBm	-19 dBm	-19 dBm
I	-28 dBm*	-32 dBm	-32 dBm	-25 dBm	-27 dBm*	-32 dBm	-32 dBm	-23 dBm	-25 dBm*	-30 dBm	-27 dBm	-24 dBm
S	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
V	-68 dBm	-36 dBm	-68 dBm	-68 dBm	-55 dBm	NB	-55 dBm	-55 dBm	-63 dBm	NB	-63 dBm	-63 dBm
ITM	-74 dBm				-61 dBm				-69 dBm			
PSD	-94 dBm/MHz				-81 dBm/MHz				-89 dBm/MHz			

* – Indicates engineering judgement was applied to determine break point

3.3.3.2 Altimeter A

Table 3-37: UC2 RA-A 2000' AGL OOB Fundamental Emissions Break Point Summary

Center Frequency	Plot	Comments
3750 MHz	Time History Figure 3-180	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-181 Figure 3-182	Mean error first exceeds the ±0.5% criterion threshold near -10 dBm. 1st percentile measured height is less than the -2% criterion threshold near -10 dBm. The first NCD occurs near -9 dBm. 99th percentile measured height is greater than the +2% criterion threshold near -9 dBm.
3850 MHz	Time History Figure 3-183	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-184 Figure 3-185	1st percentile measured height is less than the -2% criterion threshold near -15 dBm. The first NCD occurs near -14 dBm. Mean error first exceeds the ±0.5% criterion threshold near -14 dBm. 99th percentile measured height is greater than the +2% criterion threshold near -14 dBm.
3930 MHz	Time History Figure 3-186	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-187 Figure 3-188	Mean error first exceeds the ±0.5% criterion threshold at -20 dBm. 1st percentile measured height is less than the -2% criterion threshold at -20 dBm. The first NCD occurs at -19 dBm. 99th percentile measured height is greater than the +2% criterion threshold at -19 dBm.

Center Frequency = 3750 MHz

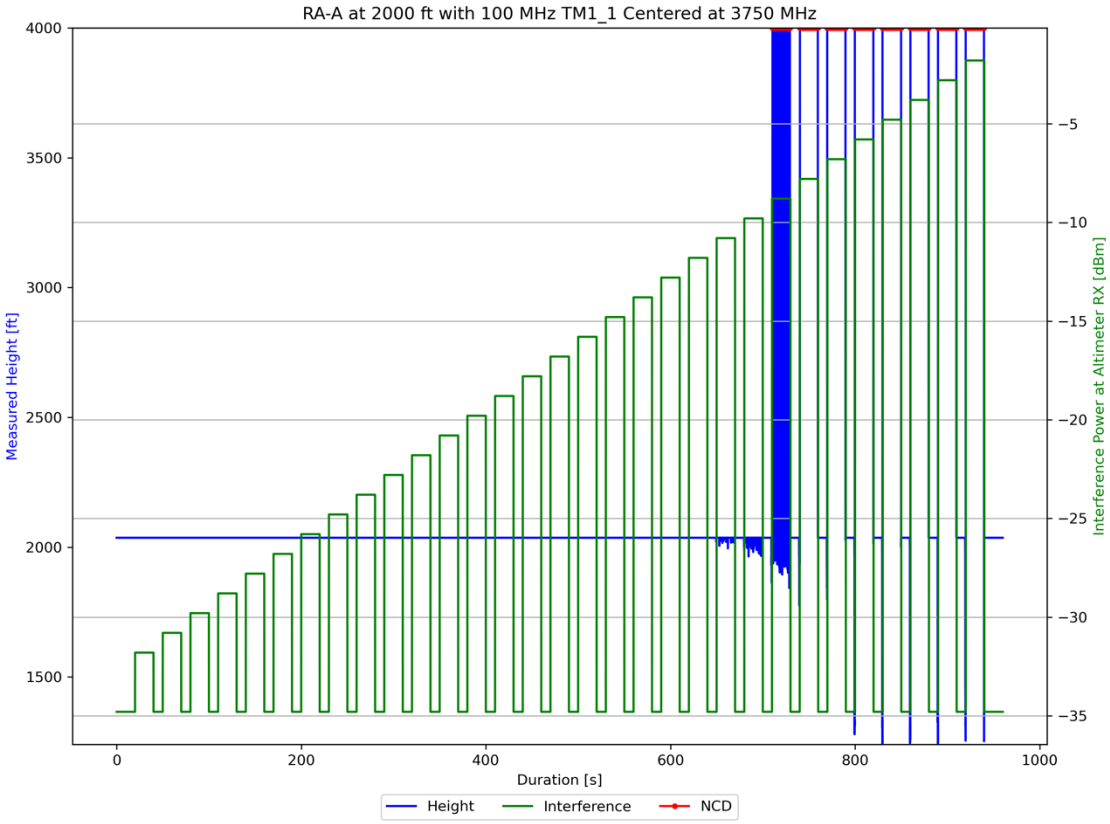

Figure 3-180: UC2 RA-A 2000' AGL Time History with TM1.1 at 3750 MHz

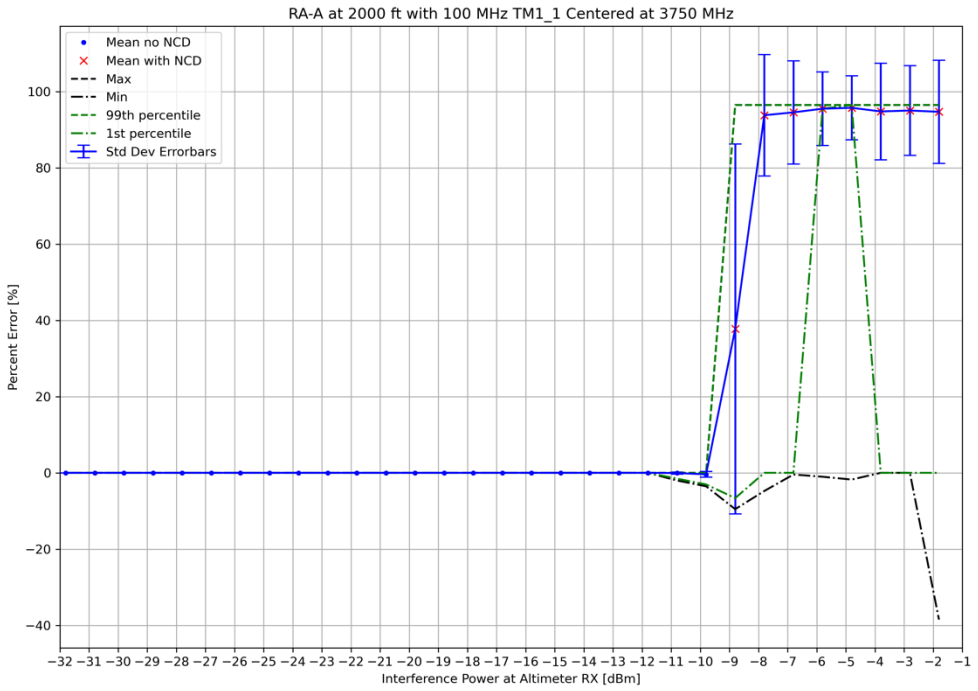

Figure 3-181: UC2 RA-A 2000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed Out

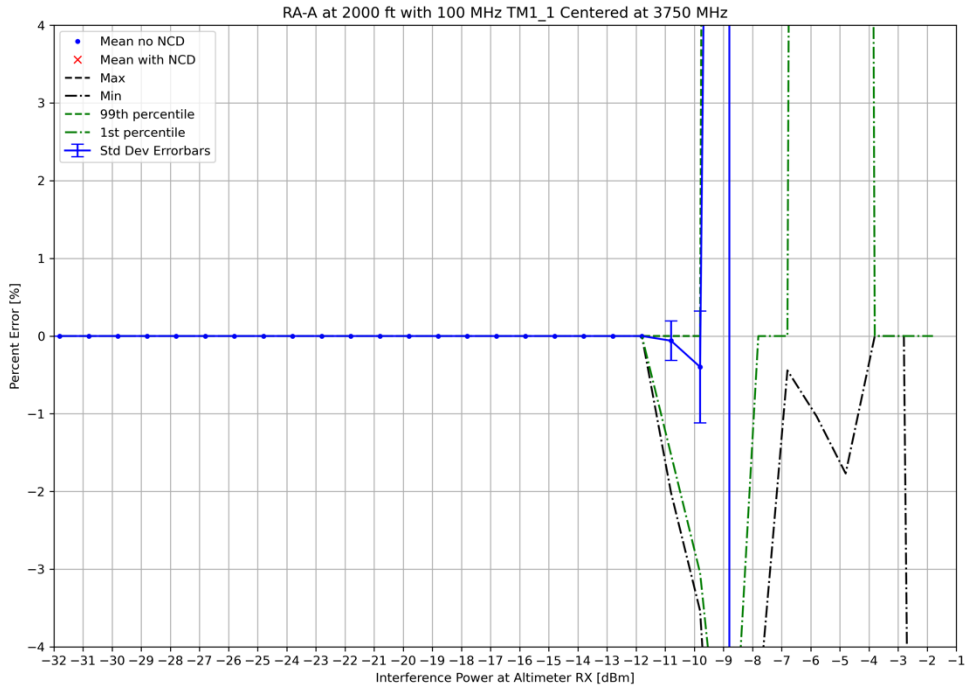

Figure 3-182: UC2 RA-A 2000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed In

Center Frequency = 3850 MHz

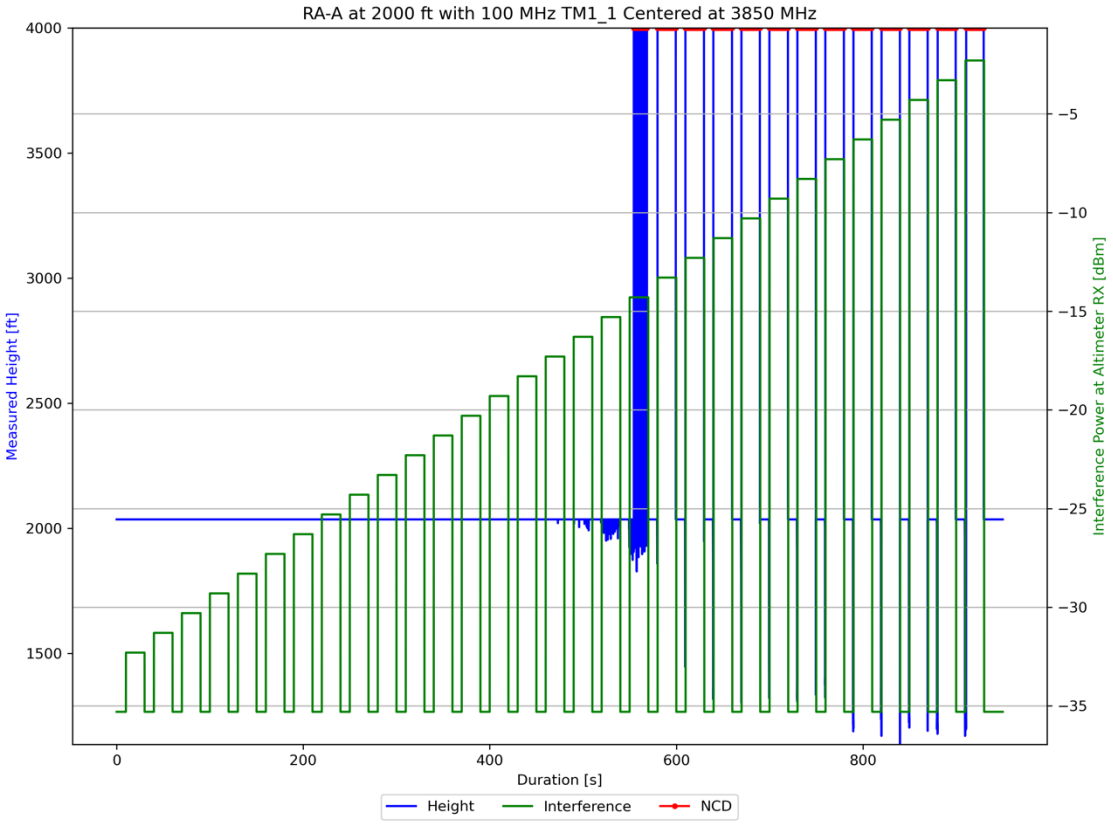

Figure 3-183: UC2 RA-A 2000' AGL Time History with TM1.1 at 3850 MHz

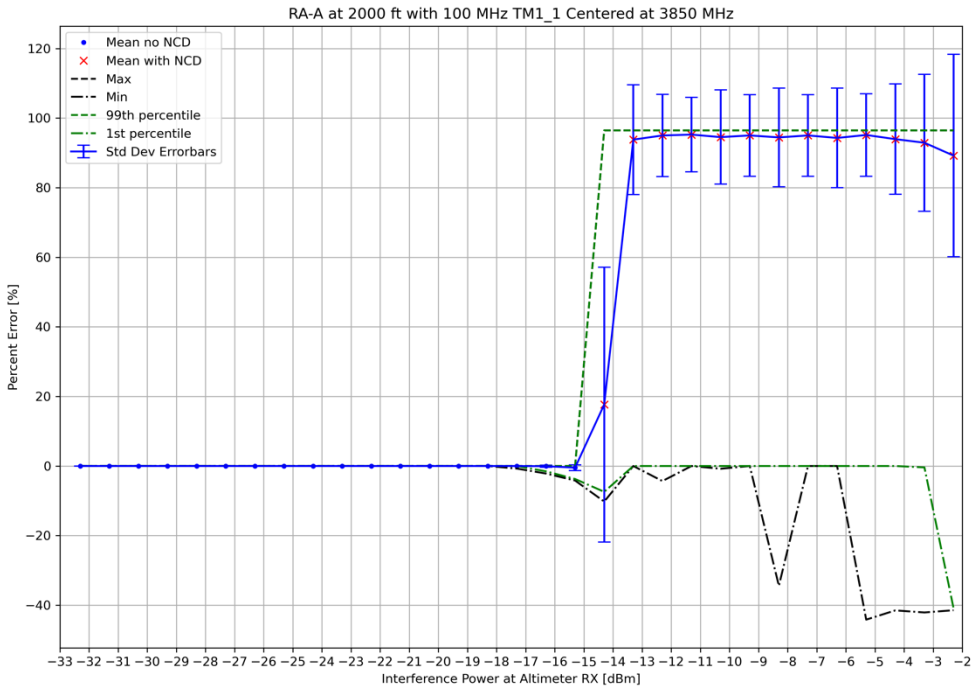

Figure 3-184: UC2 RA-A 2000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed Out

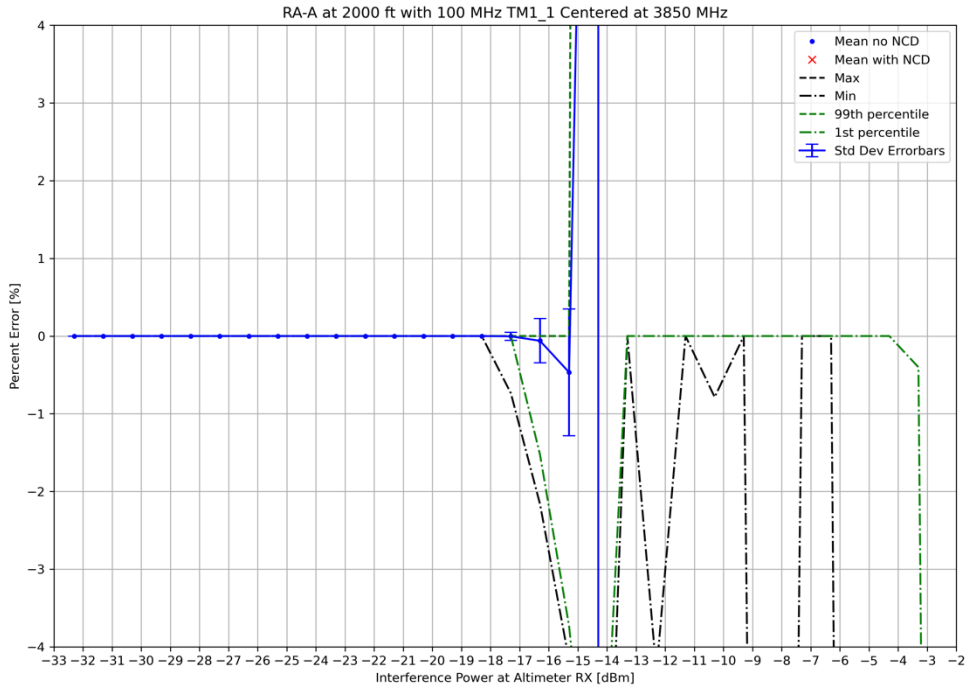

Figure 3-185: UC2 RA-A 2000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed In

Center Frequency = 3930 MHz

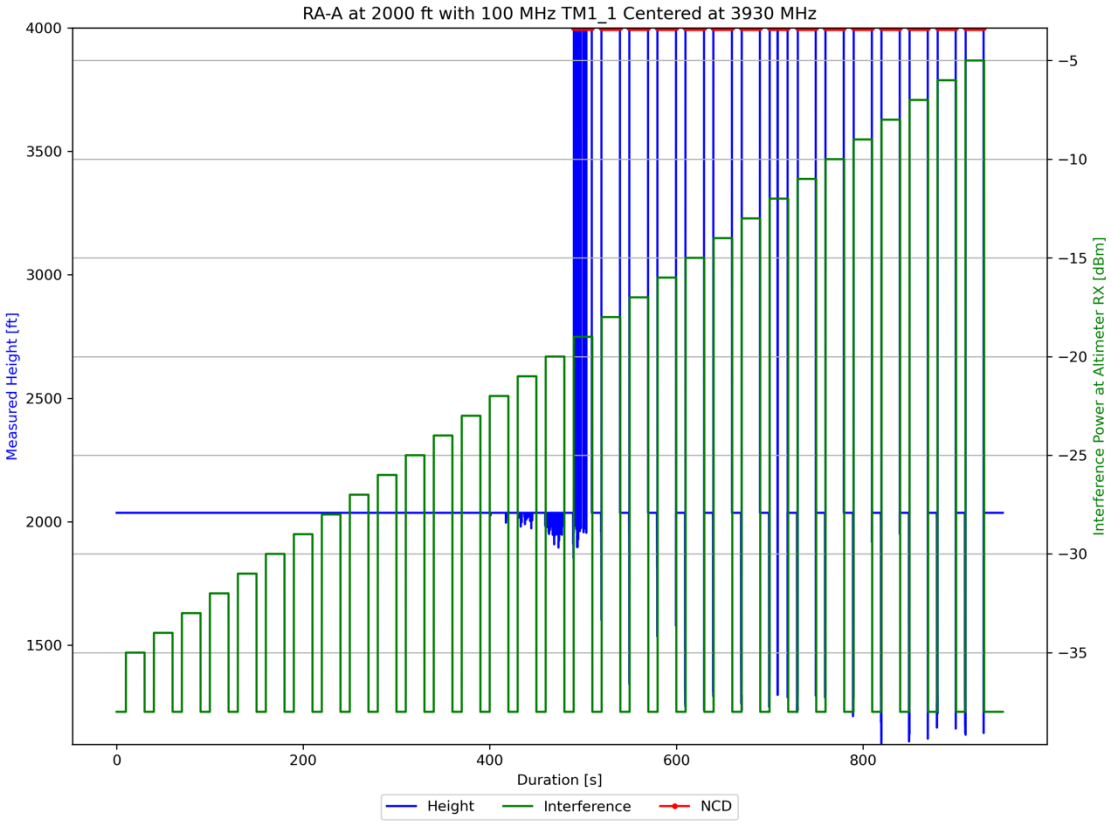

Figure 3-186: UC2 RA-A 2000' AGL Time History with TM1.1 at 3930 MHz

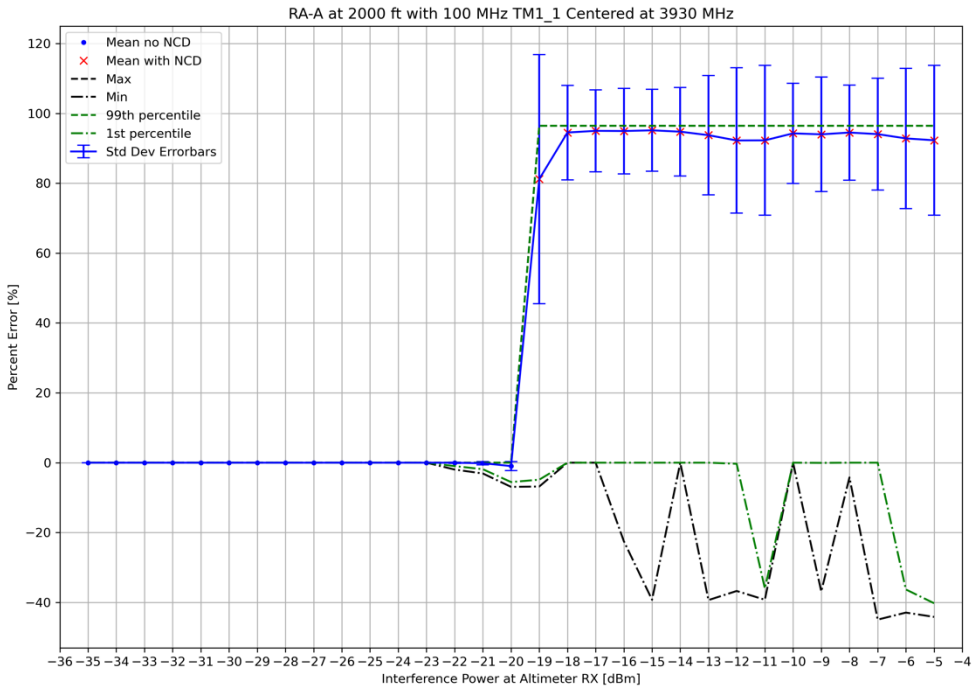

Figure 3-187: UC2 RA-A 2000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed Out

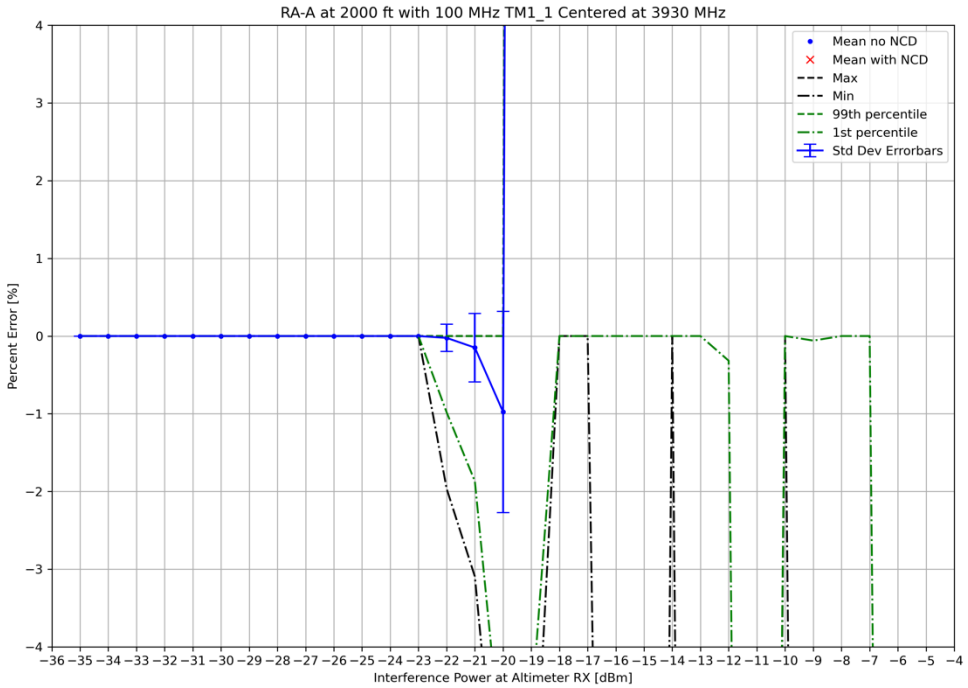

Figure 3-188: UC2 RA-A 2000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed In

3.3.3.1 Altimeter I

For Altimeter I at 2000 feet AGL, valid measured heights appear to be rounded to the nearest 50 feet. Subject matter experts agreed it was necessary to apply engineering judgement to take this height quantization into account when determining the break points.

Table 3-38: UC2 RA-I 2000' AGL OOB Fundamental Emissions Break Point Summary

Center Frequency	Plot	Comments
3750 MHz	Time History Figure 3-189	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-190 Figure 3-191	1st percentile measured height is less than the -2% criterion threshold near -32 dBm. 99th percentile measured height is greater than the +2% criterion threshold near -32 dBm. Mean error first exceeds the ±0.5% criterion threshold near -28 dBm. The first NCD occurs near -25 dBm. As described above, engineering judgment was applied to exclude the 1st and 99th percentile break points due to the height quantization for this altimeter at this altitude, thus the break point is set by the mean error criterion at -28 dBm.
3850 MHz	Time History Figure 3-192	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-193 Figure 3-194	1st percentile measured height is less than the -2% criterion threshold near -32 dBm. 99th percentile measured height is greater than the +2% criterion threshold near -32 dBm. Mean error first exceeds the ±0.5% criterion threshold near -27 dBm. The first NCD occurs near -23 dBm. As described above, engineering judgment was applied to exclude the 1st and 99th percentile break points due to the height quantization for this altimeter at this altitude, thus the break point is set by the mean error criterion at -27 dBm.

Center Frequency	Plot	Comments
3930 MHz	Time History Figure 3-195	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-196 Figure 3-197	1st percentile measured height is less than the -2% criterion threshold at -30 dBm (the value at -35 dBm is an experimental artifact from the previous power sweep). 99th percentile measured height is greater than the +2% criterion threshold at -27 dBm. Mean error first exceeds the ±0.5% criterion threshold at -25 dBm. The first NCD occurs at -24 dBm. As described above, engineering judgment was applied to exclude the 1st and 99th percentile break points due to the height quantization for this altimeter at this altitude, thus the break point is set by the mean error criterion at -25 dBm.

Center Frequency = 3750 MHz

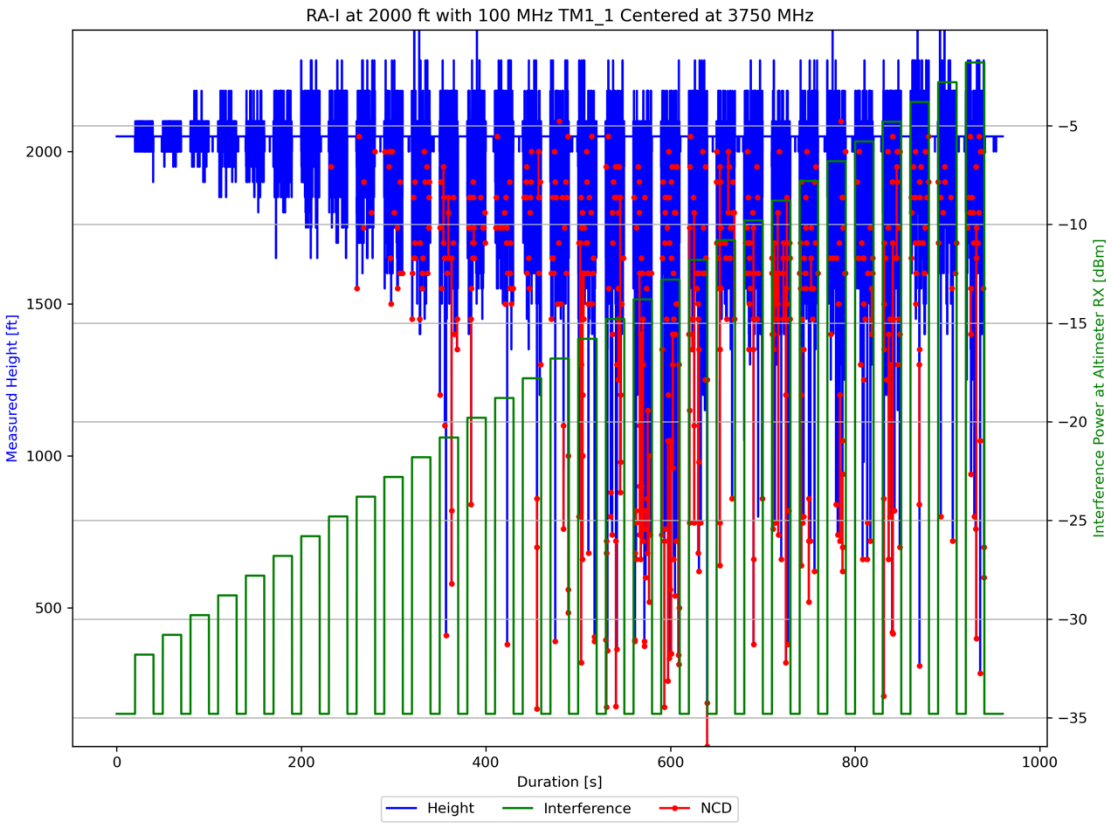

Figure 3-189: UC2 RA-I 2000' AGL Time History with TM1.1 at 3750 MHz

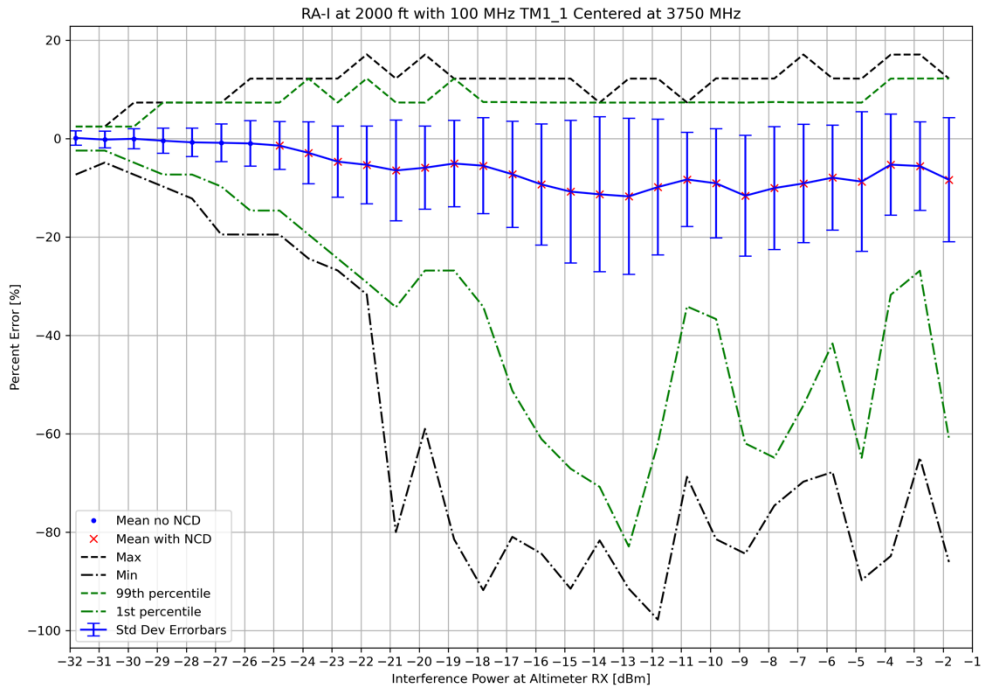

Figure 3-190: UC2 RA-I 2000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed Out

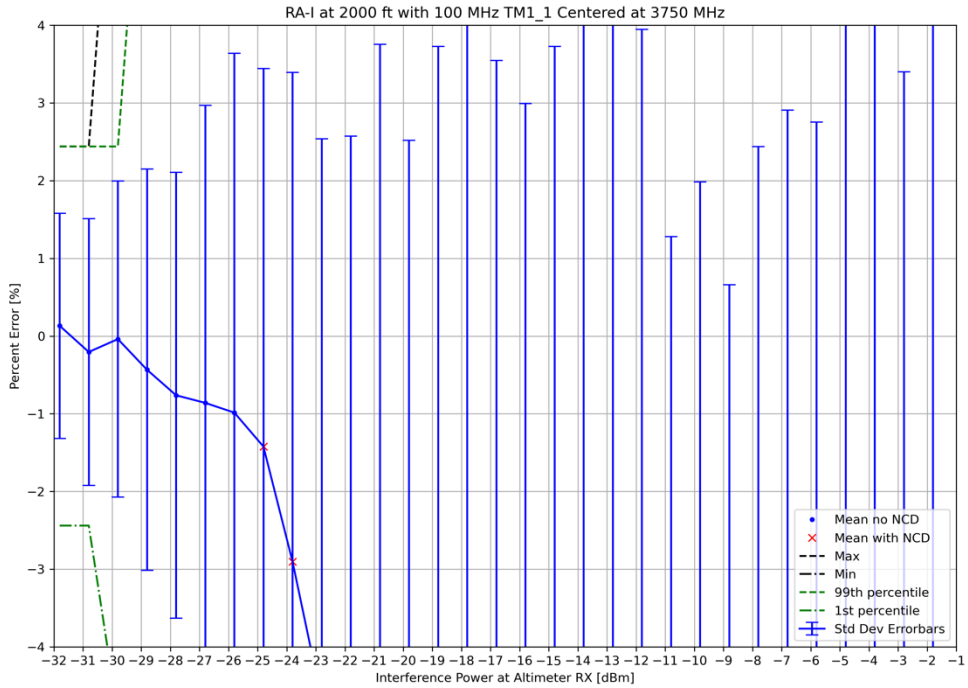

Figure 3-191: UC2 RA-I 2000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed In

Center Frequency = 3850 MHz

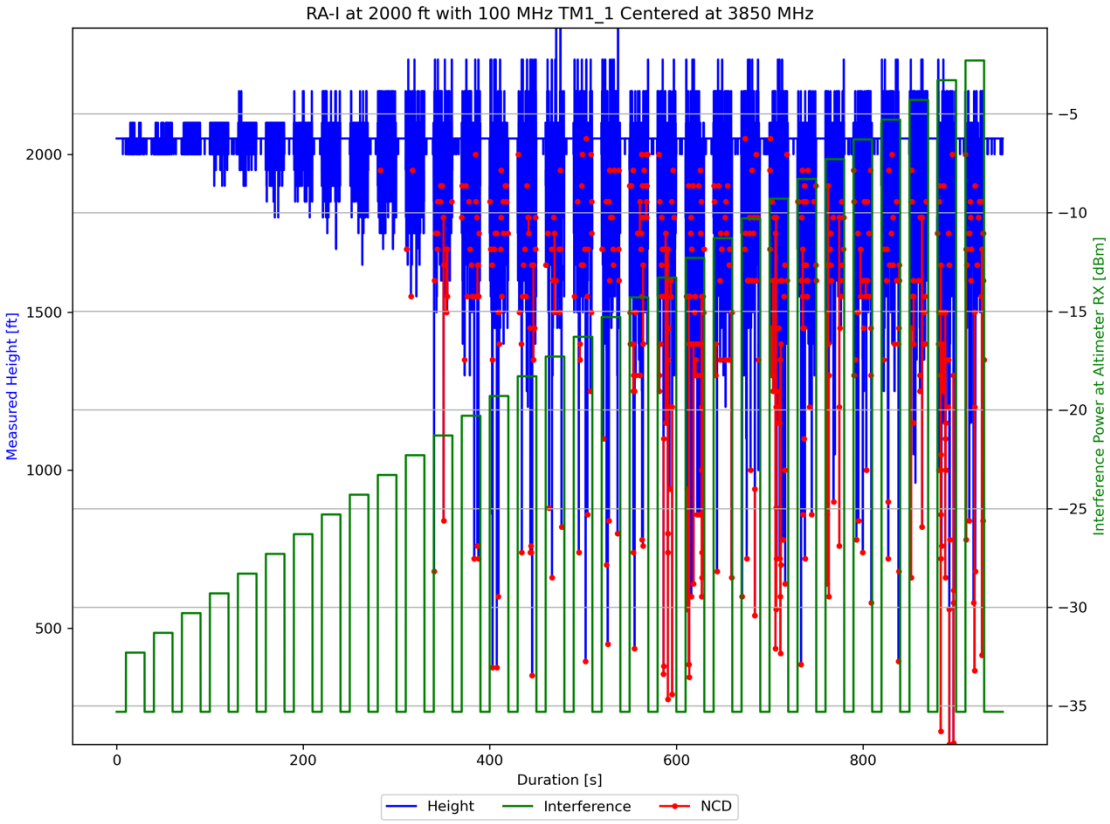

Figure 3-192: UC2 RA-I 2000' AGL Time History with TM1.1 at 3850 MHz

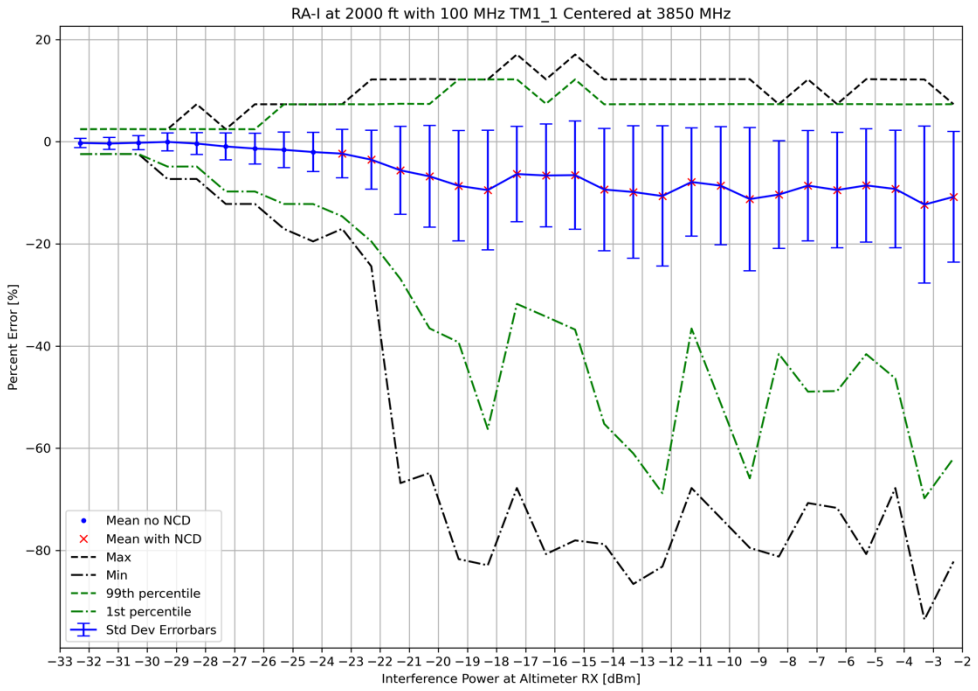

Figure 3-193: UC2 RA-I 2000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed Out

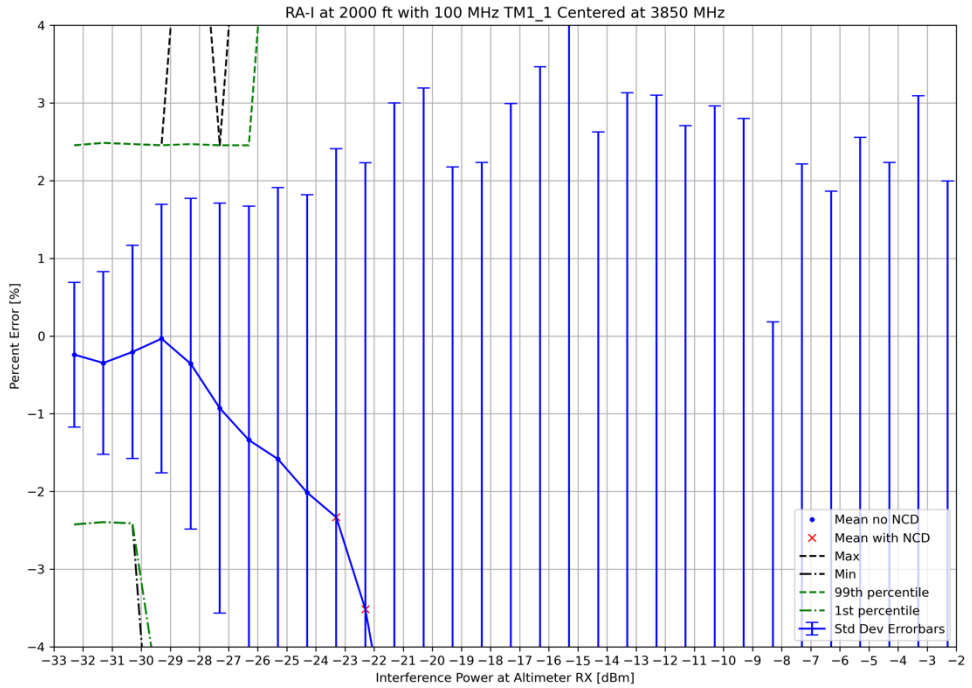

Figure 3-194: UC2 RA-I 2000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed In

Center Frequency = 3930 MHz

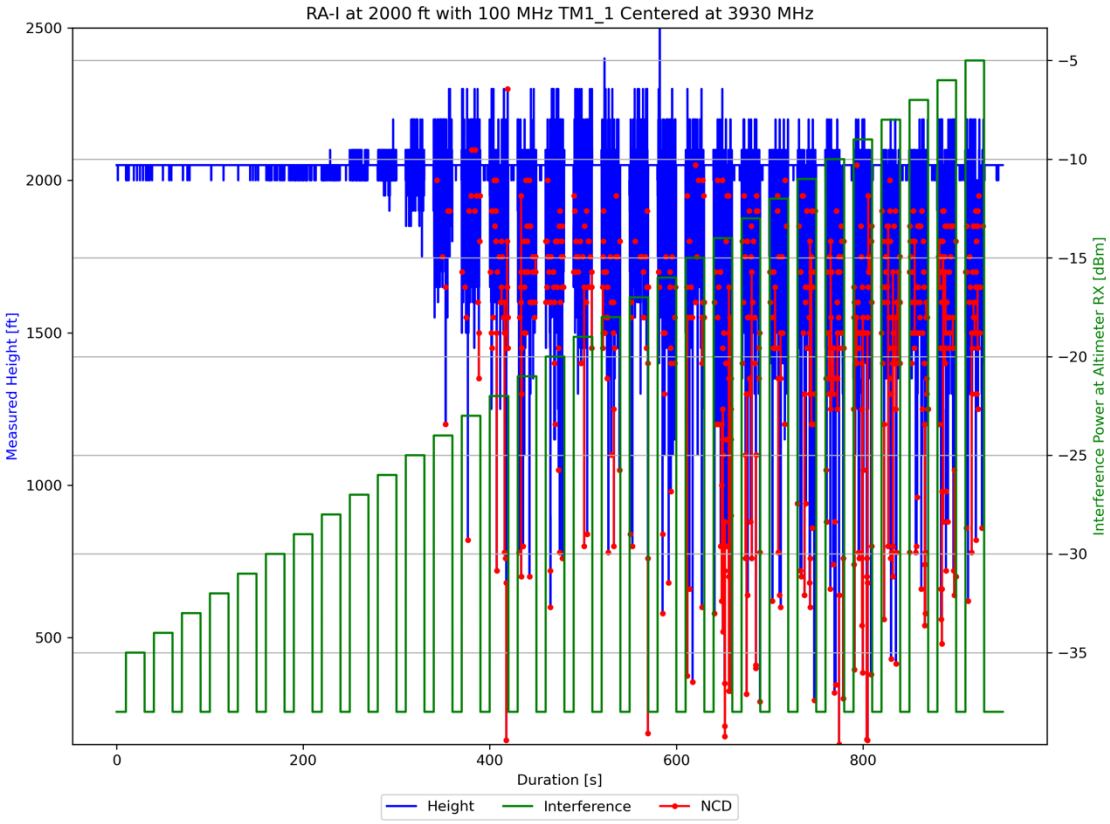

Figure 3-195: UC2 RA-I 2000' AGL Time History with TM1.1 at 3930 MHz

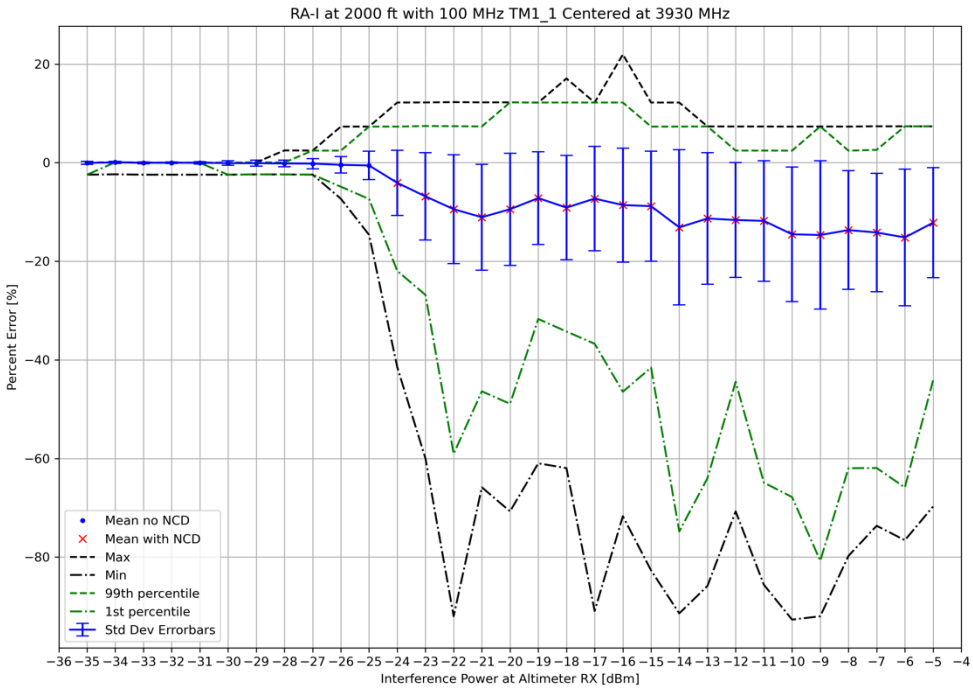

Figure 3-196: UC2 RA-I 2000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed Out

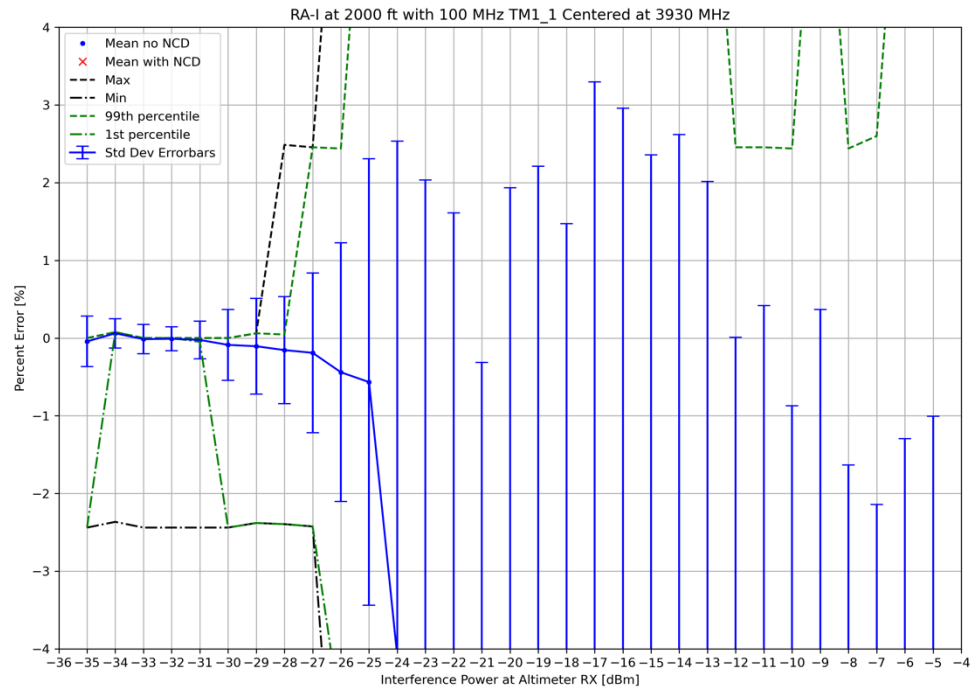

Figure 3-197: UC2 RA-I 2000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed In

3.3.3.1 Altimeter S

Table 3-39: UC2 RA-S 2000' AGL OOB Fundamental Emissions Break Point Summary

Center Frequency	Plot	Comments
3750 MHz	Time History Figure 3-198	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-199	No break observed.
3850 MHz	Time History Figure 3-200	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-201	No break observed.
3930 MHz	Time History Figure 3-202	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-203	No break observed.

Center Frequency = 3750 MHz

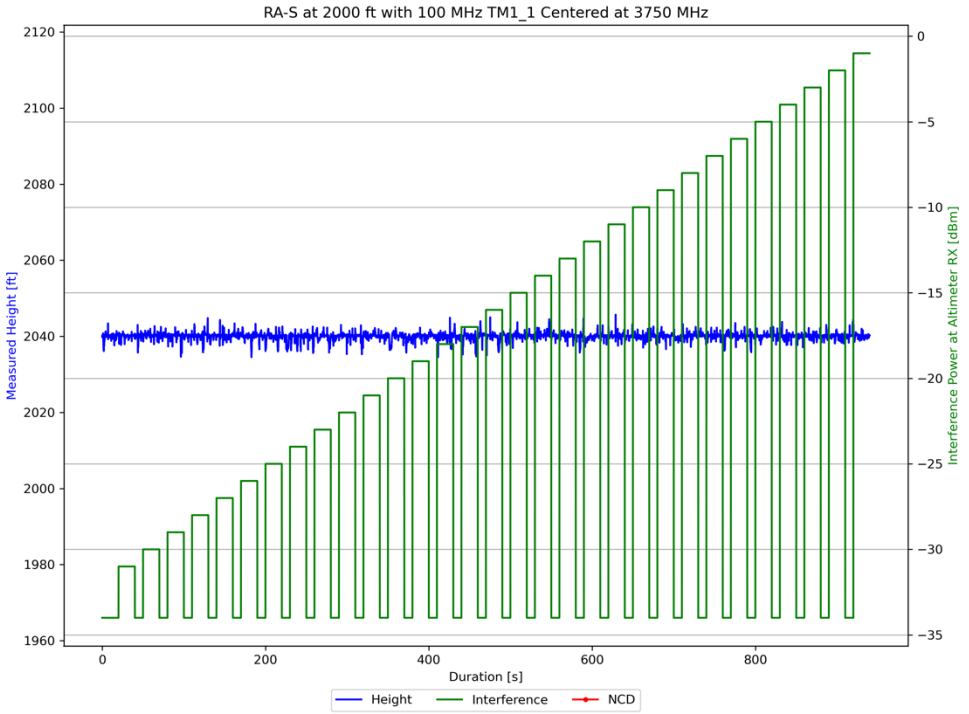

Figure 3-198: UC2 RA-S 2000' AGL Time History with TM1.1 at 3750 MHz

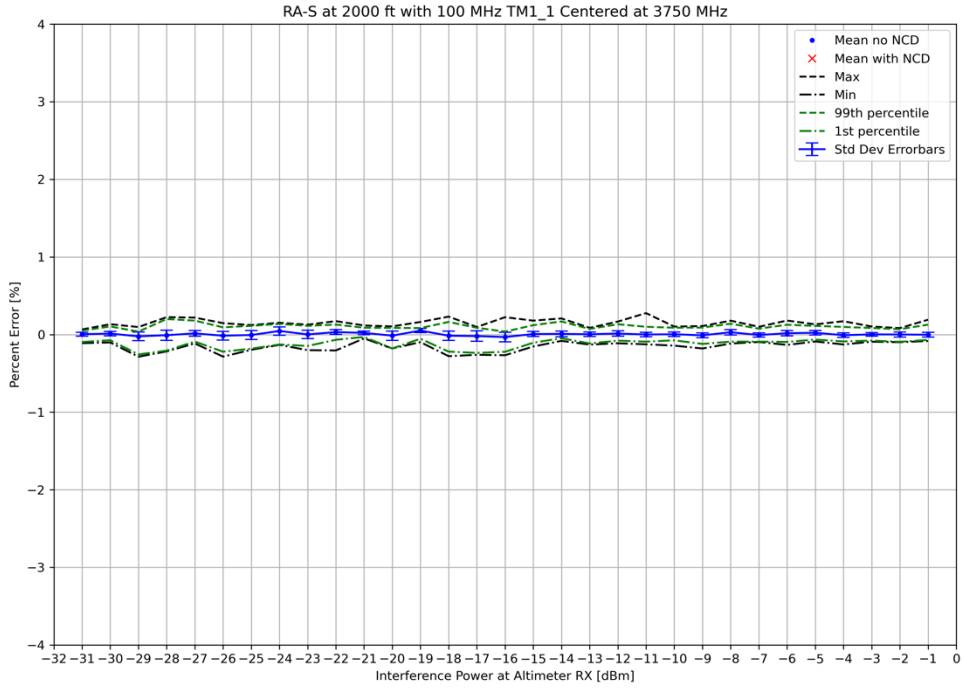

Figure 3-199: UC2 RA-S 2000' AGL Statistics with TM1.1 at 3750 MHz

Center Frequency = 3850 MHz

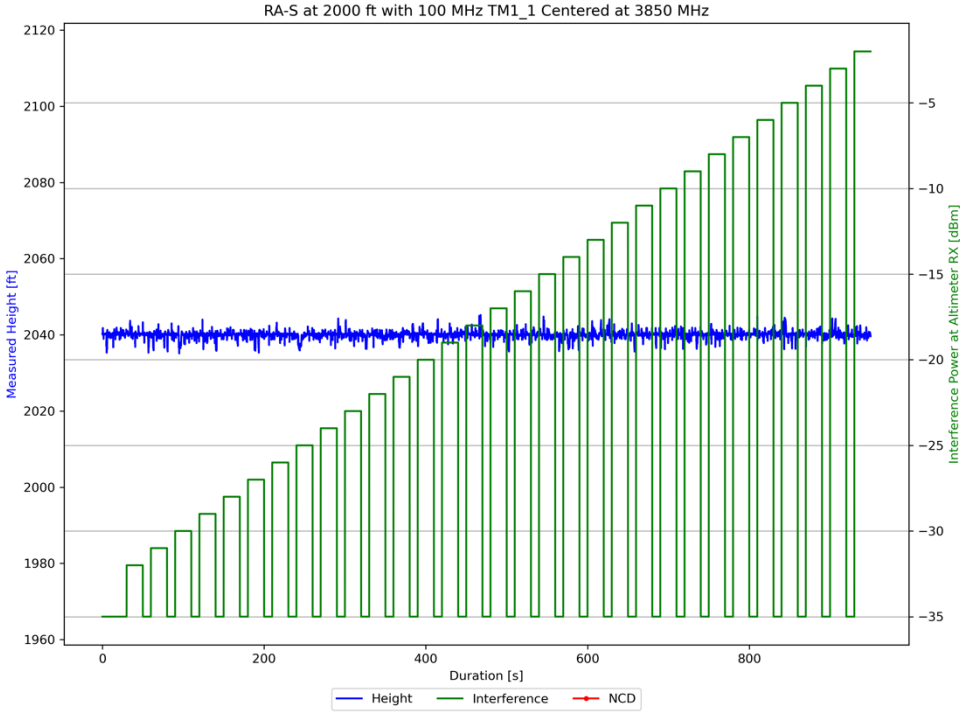

Figure 3-200: UC2 RA-S 2000' AGL Time History with TM1.1 at 3850 MHz

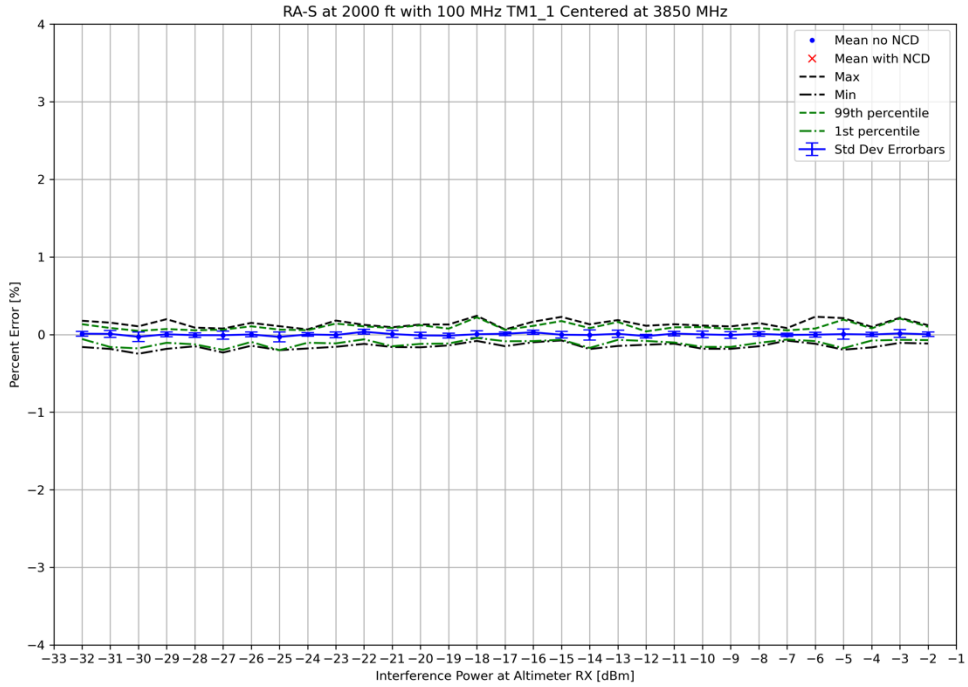

Figure 3-201: UC2 RA-S 2000' AGL Statistics with TM1.1 at 3850 MHz

Center Frequency = 3930 MHz

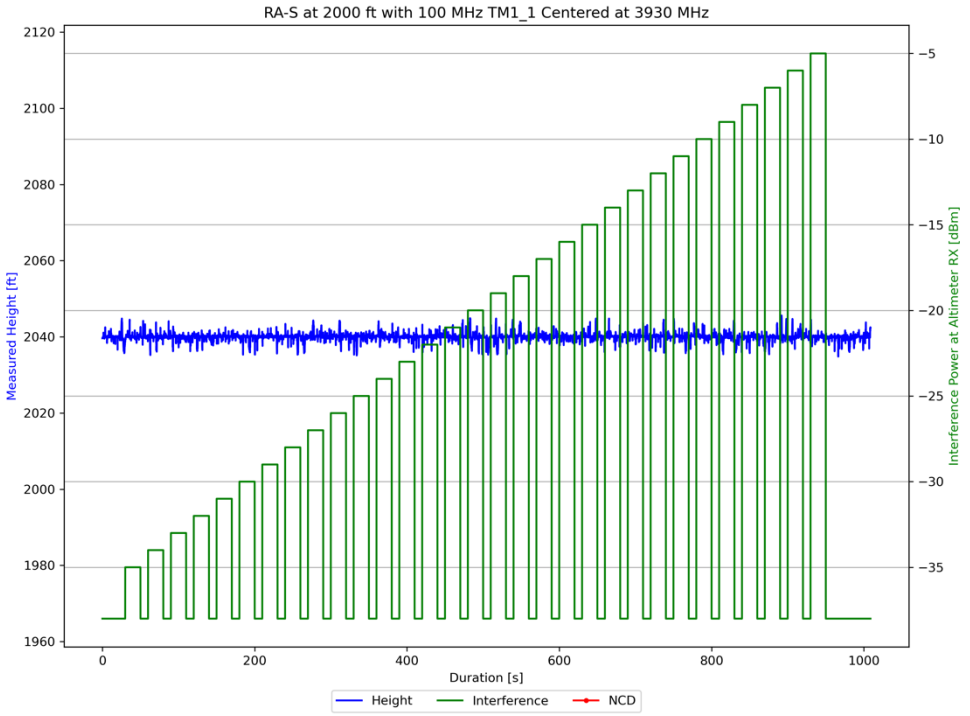

Figure 3-202: UC2 RA-S 2000' AGL Time History with TM1.1 at 3930 MHz

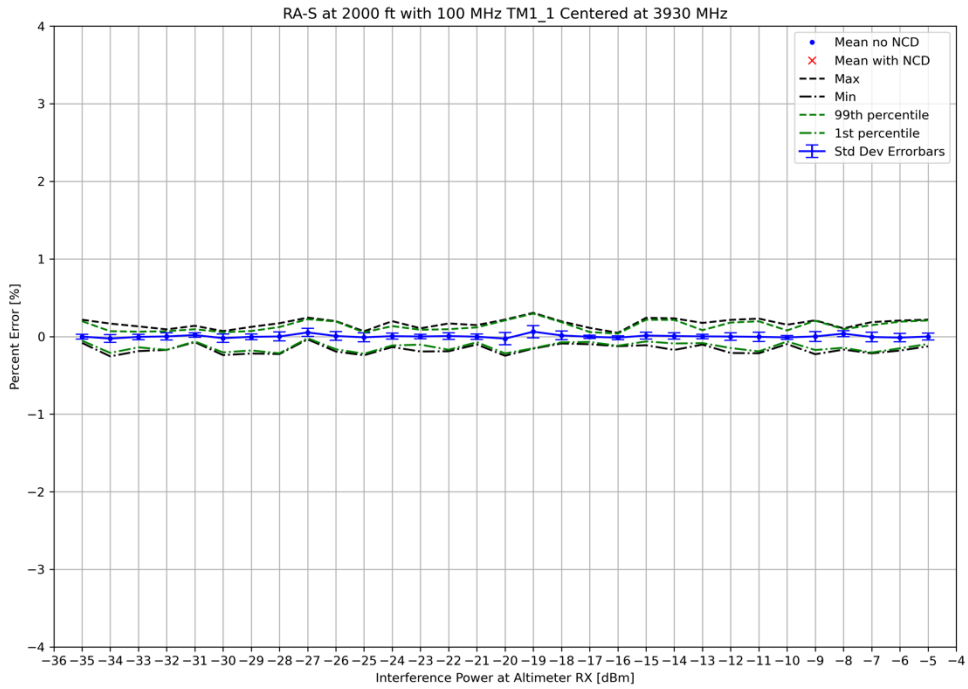

Figure 3-203: UC2 RA-S 2000' AGL Statistics with TM1.1 at 3930 MHz

3.3.3.1 Altimeter V

Table 3-40: UC2 RA-V 2000' AGL OOB Fundamental Emissions Break Point Summary

Center Frequency	Plot	Comments
3750 MHz	Time History Figure 3-204	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-205 Figure 3-206	Mean error greater than 0.5%, 99th percentile greater than 2%, and NCD criteria break points occur near -68 dBm. 1st percentile measured height is less than the -2% criterion threshold near -36 dBm. Note that this altimeter reports 4000 feet when an NCD occurs, thus the NCD criterion sets the break point since this affects the other statistics.
3850 MHz	Time History Figure 3-207	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-208 Figure 3-209	Mean error greater than 0.5%, 99th percentile greater than 2%, and NCD criteria break points occur at -55 dBm. Note that this altimeter reports 4000 feet when an NCD occurs, thus the NCD criterion sets the break point since this affects the other statistics.
3930 MHz	Time History Figure 3-210	Shows magnitude of change in measured height over time for increasing interference power levels.
	Statistics Figure 3-211 Figure 3-212	Mean error greater than 0.5%, 99th percentile greater than 2%, and NCD criteria break points occur at -63 dBm. Note that this altimeter reports 4000 feet when an NCD occurs, thus the NCD criterion sets the break point since this affects the other statistics.

Center Frequency = 3750 MHz

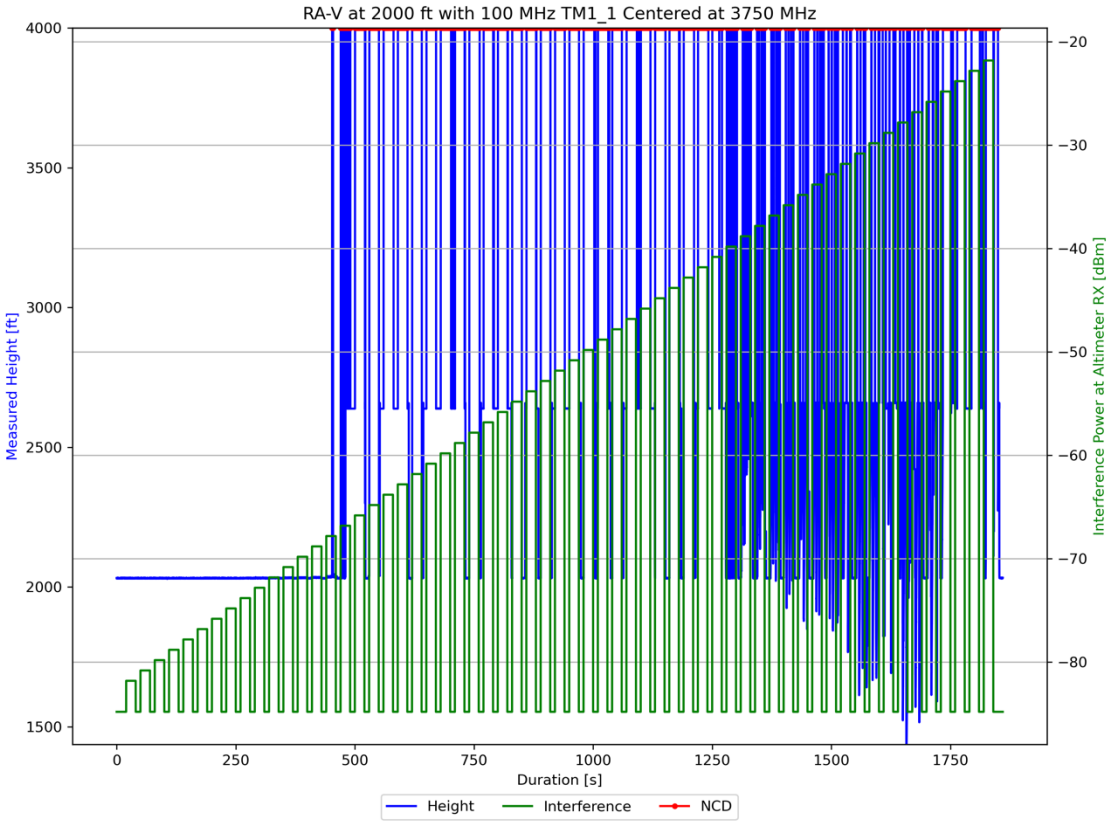

Figure 3-204: UC2 RA-V 2000' AGL Time History with TM1.1 at 3750 MHz

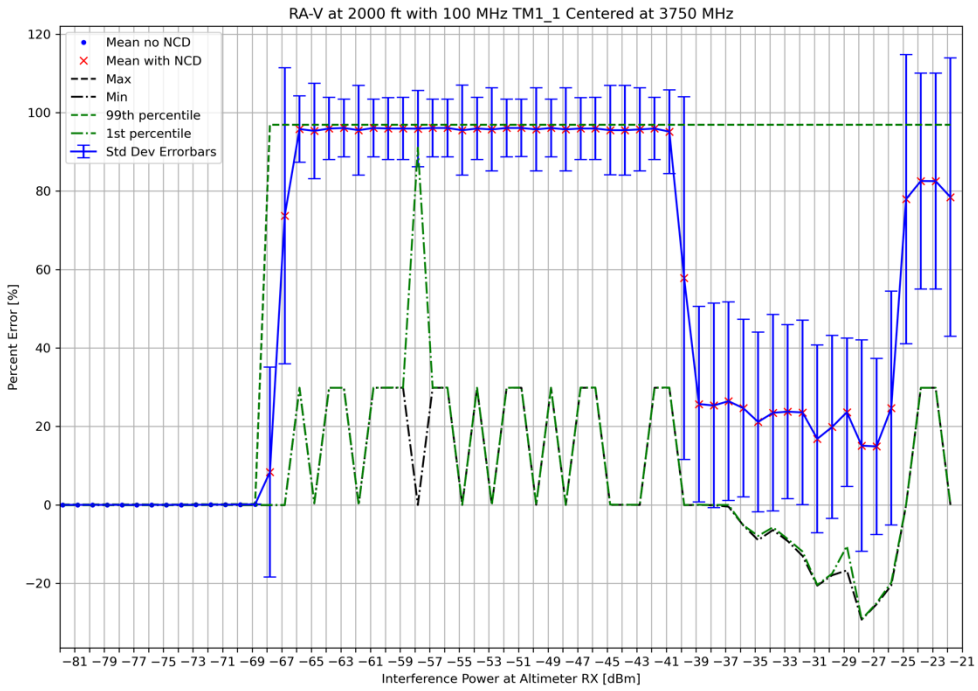

Figure 3-205: UC2 RA-V 2000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed Out

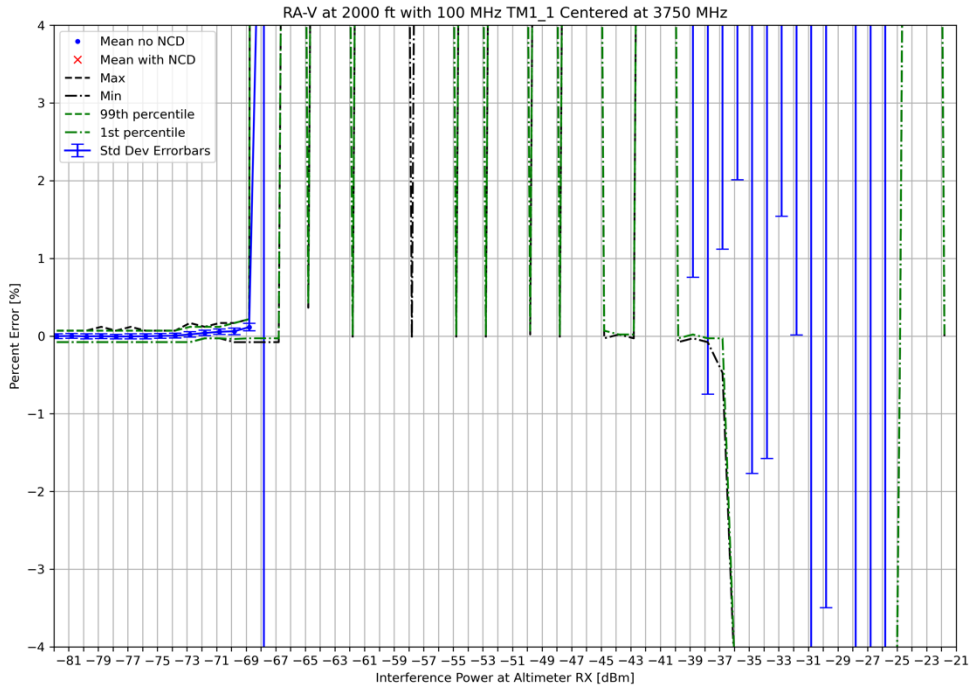

Figure 3-206: UC2 RA-V 2000' AGL Statistics with TM1.1 at 3750 MHz – Zoomed In

Center Frequency = 3850 MHz

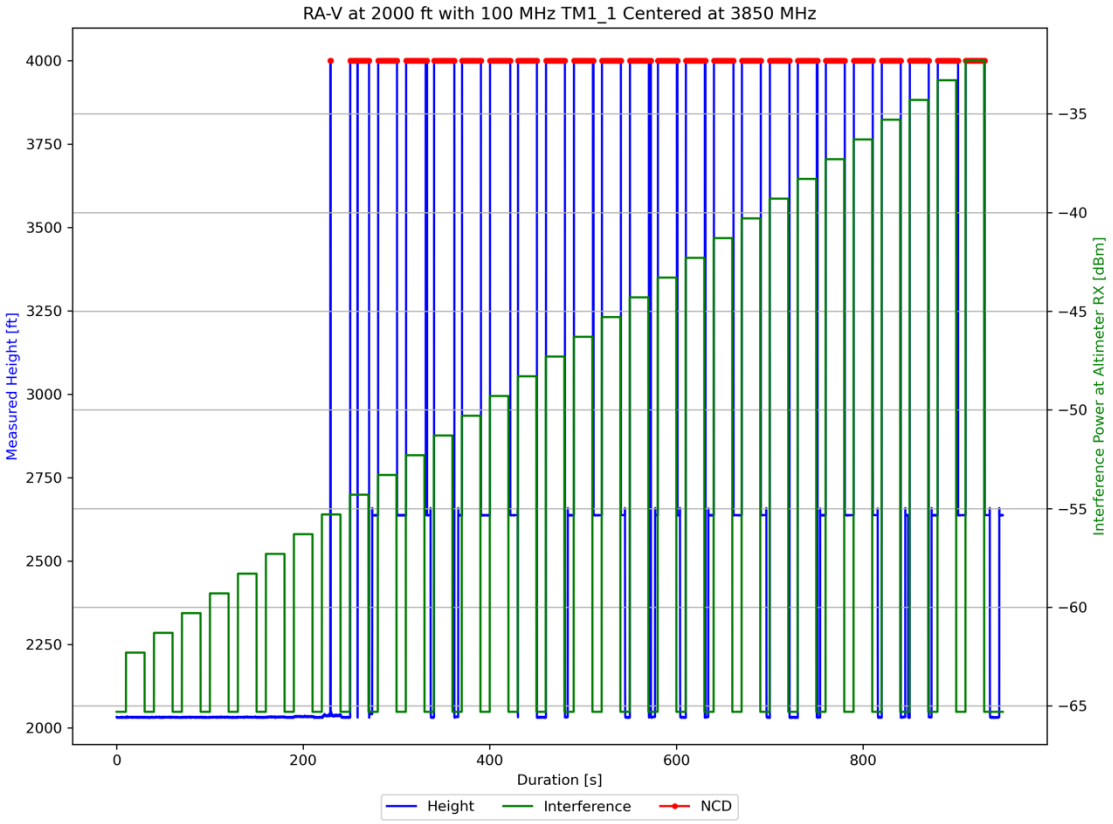

Figure 3-207: UC2 RA-V 2000' AGL Time History with TM1.1 at 3850 MHz

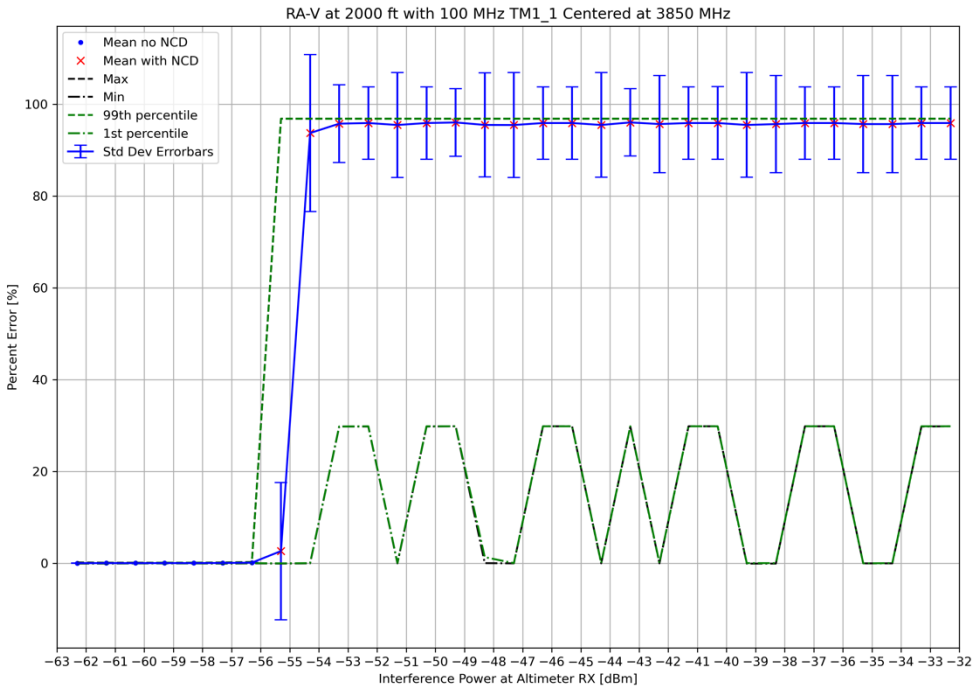

Figure 3-208: UC2 RA-V 2000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed Out

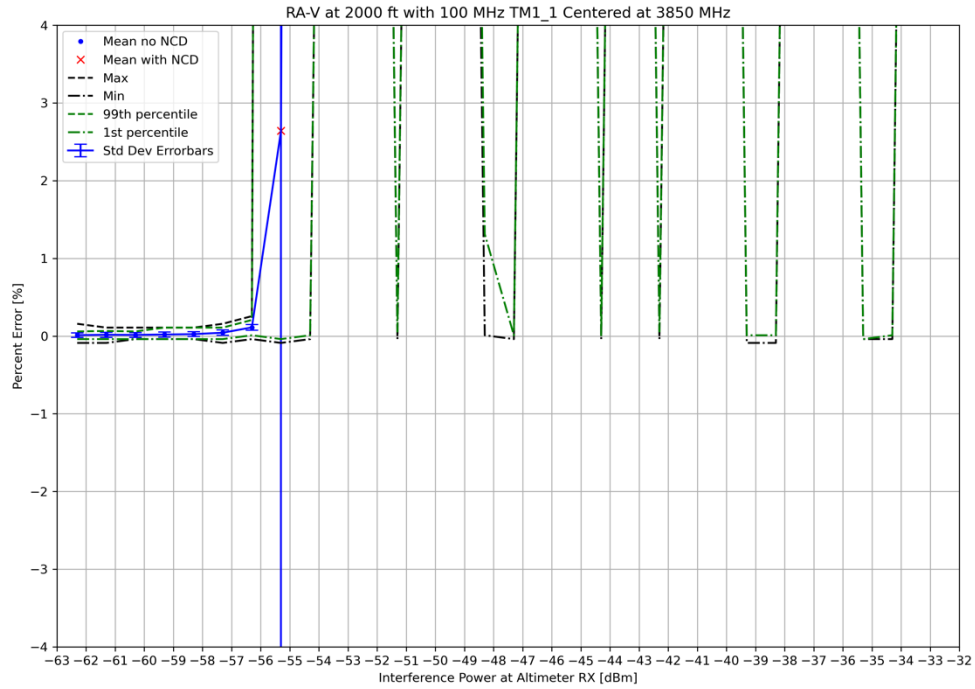

Figure 3-209: UC2 RA-V 2000' AGL Statistics with TM1.1 at 3850 MHz – Zoomed In

Center Frequency = 3930 MHz

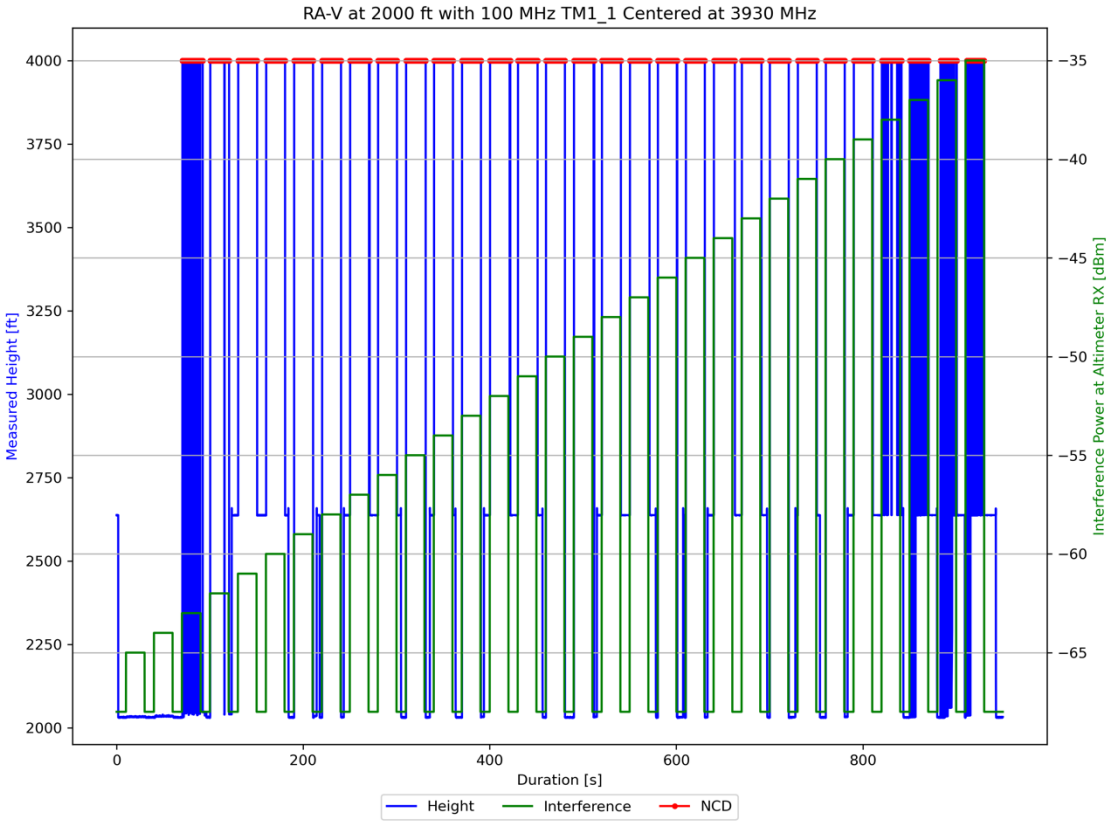

Figure 3-210: UC2 RA-V 2000' AGL Time History with TM1.1 at 3930 MHz

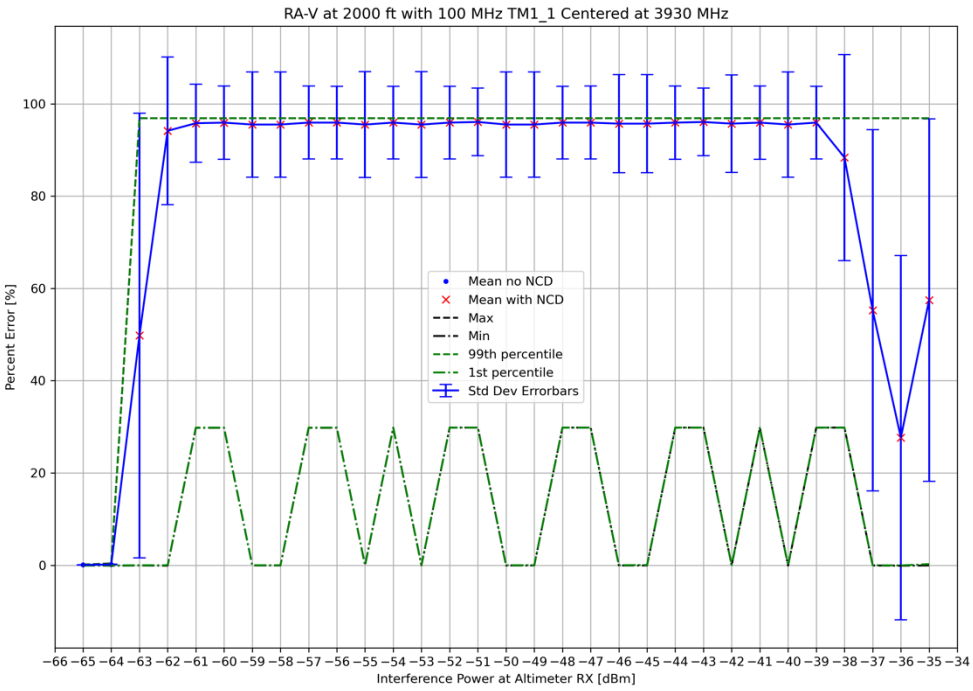

Figure 3-211: UC2 RA-V 2000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed Out

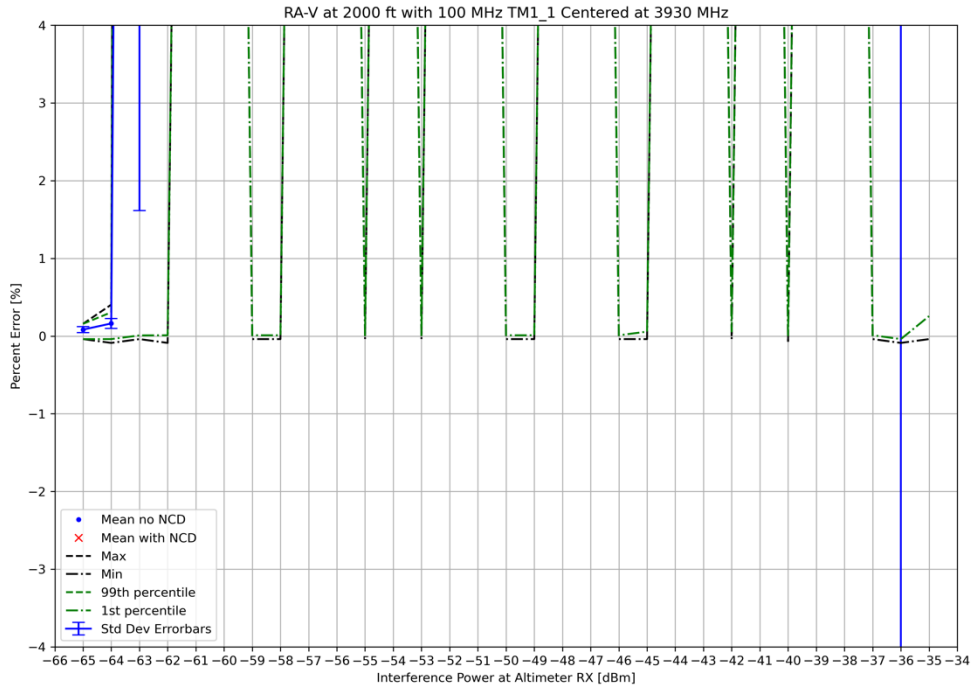

Figure 3-212: UC2 RA-V 2000' AGL Statistics with TM1.1 at 3930 MHz – Zoomed In